Project Title:
Development of an optimized tide and hurricane storm surge model for the west coast of FL for use with the ADCIRC Surge Guidance System.

Principal Investigator Name/Institution:
Scott C. Hagen, Professor - Louisiana State University, Department of Civil & Environmental Engineering / Center for Computation & Technology, Director - Center for Coastal Resiliency

Other Research Partners/Institutions:

Stephen C. Medeiros, Lecturer, University of Central Florida, Department of Civil, Environmental & Construction Engineering / Institute for Simulation and Training.
Matthew V. Bilskie, Research Scientist, Louisiana State University, Center for Coastal Resiliency.

Short Project Description ("elevator speech"):

This project will simplify an existing high-definition research-grade tide, wind-wave, and hurricane storm surge model of the west coast of Florida for use in the ADCIRC (Advanced Circulation) Surge Guidance System (ASGS). The goal is to enable the model to complete a 5-day simulation forecast in less than 1 hour, while retaining water surface elevations that are within 10-percent of the original research-grade model. Achieving this goal reduces model run times (from several hours to 1 hour) so that end-users will have model forecast guidance in a timelier fashion.

1. Introduction and project overview:

The research need that this project is addressing is a means to develop a computationally efficient hurricane storm surge model with sufficient detail across the coastal floodplain. Storm surge simulations will be generated in near real-time during an impending tropical cyclone event in order to provide surge guidance to emergency managers and stakeholders.

2. Results:

Outcomes of Year 4:
- Full production (transition – see Item 4 below) of the real-time grade northern Gulf of Mexico ADCIRC mesh and model (NGOM-RT) for the 2018 hurricane season, which includes Subtropical Storm Alberto, Tropical Storm Gordon, and Hurricane Michael. This outcome is a combination of a product (NGOM-RT storm surge model) and its application in real-time. The deployment of this model was a huge success. Results generated by this model were the default view on the Coastal Emergency Risks

Assessment (CERA) visualization website (cera.coastalrisk.live) during Hurricane Michael.
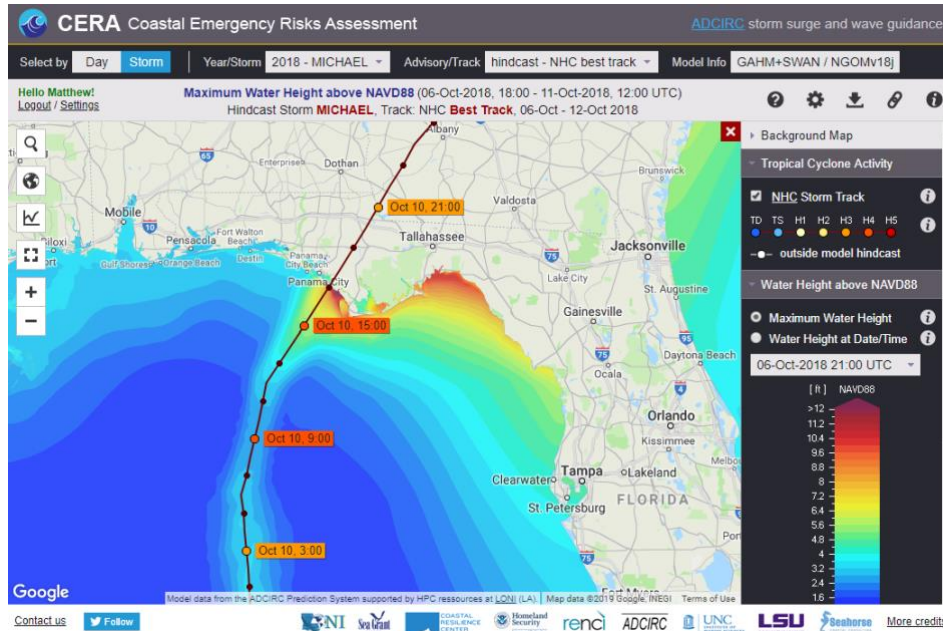

Figure 1. Hurricane Michael results generated by the NGOM-RT model
as shown by CERA.

- Preliminary hindcast and error quantification of Hurricane Michael using the NGOM-RT ADCIRC model (research findings). A manuscript is currently being written on this topic (see Item 9 below).
- Initial development of a forecast-grade ADCIRC model for the west coast of Florida (product).

3. End users:

Dr. Medeiros conducted a 90-minute workshop on CERA to FDOT District 5 on June 18, 2019. The workshop focused on the key features of CERA that would be relevant to FDOT's needs. All participants provided valuable feedback on adaptations to CERA that would make the tool more useful to their operations. This workshop was attended by:

- John Hatfield
  - District Maintenance Engineer / District Emergency Coordinator
- Doni Laney
  - District Safety and Health Manager
- Dennis Kirk
  - Deputy District Maintenance Administrator, Assistant District Emergency Coordinator
- Ed Kestory
  - District Structures Maintenance Engineer
- Jonathan Jastremsky
  - Engineering Section Manager – Structures Maintenance

4. Transition:

The transition of results was outlined in Item 2 with respect to the transition of the developed NGOM-RT model to production, particularly with Hurricane Michael.

There have not been any transition activities at this time in regard to the west Florida storm surge model.

5. Project Impact:

The capability to provide high fidelity storm surge forecasts, as shown through the production of advanced technology developed as part of this project, via increased operational efficiency in real-time has a direct real-world impact. There is no doubt that the forecasts provided by the NGOM-RT model during Hurricane Michael played a role in saving lives, money, and property.

6. Unanticipated Problems:

The delay and splitting of Year 4 funds substantially impacted the progress of this project. To overcome this, Dr. Medeiros used faculty accounts to cover the shortcoming for the undergraduate student's stipend (See Section 7).

7. Student Involvement and Awards:

Dr. Medeiros used project funds to support Makayla Maduro. She assisted with literature review and various other research related tasks. She is also interested in building hurricane storm surge models of one or more Caribbean islands.

Student demographics: Ms. Maduro is a West Indian female undergraduate student at UCF with a dual major in Civil and Construction Engineering.

Degrees attained:

NA

Student Awards.

NA

8. Interactions with education projects:
NA

9. Publications:

- Santiago-Collazo, F.L., Bilskie, M.V., Hagen, S.C. (2019) "A comprehensive review of compound inundation models," *Environmental Modelling & Software*, Accepted June 17.

- Bilskie, M.V., Asher, T.G., Fleming, J.G., Hagen, S.C., Kaiser, C., Luettich Ur., R.A., Twilley, R. (2019) "Real-time storm surge predictions during Hurricane Michael," *Geophysical Research Letters*, In Progress (Previously submitted and being revised).
- Bilskie, M.V., Hagen, S.C., Medeiros, S.C. (2019) "Unstructured finite element mesh development for real-time hurricane storm surge forecasting," *Coastal Engineering*, In Preparation.

10. <u>Year 4 Research Activities and Milestone Achievements:</u>

Year 4 Research Activities and Milestones: Status as of 6/30/2019

Reporting Period 7/1/2018 – 6/30/2019			
<u>Research Activity</u>	<u>Proposed Completion Date</u>	<u>% Complete</u>	<u>Explanation of why activity/milestone was not completed</u>
Obtain FEMA Flood Map Modernization Model for FL West Coast	10/31/2018	100%	
Optimize FEMA Flood Map Modernization Model for FL West Coast. The result will be a forecast-grade, real-time, model of the FL West coast. This will provide timelier model forecasts without reducing model error.	3/31/2019	25%	Funding Delay
Perform test simulations and model validation of the real-time model of the FL West coast within the ADCIRC Surge Guidance System (ASGS) modeling framework on the LSU and LONI HPC systems. This will enable identifying potential model errors or bugs prior to full implementation during the active hurricane season.	4/30/2019	0%	Funding Delay / Audacious Year 4 Activity
Test the real-time model of the West FL coast on the UCF STOKES HPC system. This will ensure that a redundant back-up is available on a separate HPC platform in the case that a failure or shut-down occurs on the LSU or LONI systems.	5/31/2019	0%	Funding Delay/ Audacious Year 4 Activity
<u>Research Milestone</u>			
The real-time FL West Coast model will be fully connected to CERA. Model testing, evaluation, and validation will be complete.	6/1/2019	0%	Funding Delay/ Audacious Year 4 Milestone
Submission of manuscript on the development and validation of FL west coast model to a peer-reviewed journal.	6/30/2019	0%	Funding Delay/ Audacious Year 4 Milestone

11. Year 4 Transition Activities and Milestone Achievements:

Year 4 Transition Activities and Milestones: Status as of 6/30/2019

Reporting Period 7/1/2018 – 6/30/2019			
Transition Activity	Proposed Completion Date	% Complete	Explanation of why activity/milestone was not completed
Develop a 1 – 2 hour training program for introducing CERA to new end users. Training will focus, but not be limited, to new end-users and partners along the west coast of Florida. Stephen Medeiros will lead the identification of end users.	12/31/2018	100%	
Share the CERA training materials with the CERA team and request feedback in order to finalize the training materials. Feedback from the CERA research team will be incorporated into the final set of training materials.	3/31/2019	50%	Shared with script for FDOT workshop with CERA team
CERA Training Complete for 5/10 the identified end users. End users will be proficient in operating the CERA online platform.	6/01/2019	100%	Workshop for 5 end users at FDOT conducted on June 18, 2019
Transition Milestone			
CERA Training Complete for 5/10 of the identified end users. End users will be proficient in operating the CERA online platform.	6/01/2019	100%	
Integration of minimally modified real-time forecast-grade FL West Coast model into the ASGS. During an impending tropical cyclone event with potential impacts to the region results from the ASGS will be delivered to the CERA online visualization platform.	6/01/2019	0%	Funding Delay

12. Tables

    Table 1: Research Project Product Delivery

    N/A

Table 2: Performance Metrics

HAGEN-MEDEIROS-BILSKIE Performance Metrics

Metric	Year 1 (1/1/16 – 6/30/16)	Year 2 (7/1/16 – 6/30/17)	Year 3 (7/1/17-6/30/18)	Year 4 (7/1/18-6/30/19)
HS-related internships (number)				
Undergraduates provided tuition/fee support (number)				
Undergraduate students provided stipends (number)		1	1	1
Graduate students provided tuition/fee support (number)	1	1		
Graduate students provided stipends (number)	1	1		
Undergraduates who received HS-related degrees (number)				
Graduate students who received HS-related degrees (number)				
Graduates who obtained HS-related employment (number)				
SUMREX program students hosted (number)	1	2		
Lectures/presentations/seminars at Center partners (number)				
DHS MSI Summer Research Teams hosted (number)				
Journal articles submitted (number)				2
Journal articles published (number)	1	1		1
Conference presentations made (number)			1	1
Other presentations, interviews, etc. (number)	8	10	1	3
Patent applications filed (number)				
Patents awarded (number)				
Trademarks/copyrights filed (number)				
Requests for assistance/advice from DHS agencies (number)		1		
Requests for assistance/advice from other agencies or governments (number)		2		1
Dollar amount of external funding	$0	$0	$0	
Total milestones for reporting period (number)	3	4		4
Accomplished fully (number)	0	5	3	1
Accomplished partially (number)	3	2	3	1
Not accomplished (number)	0			2